Nanofabricated Platforms for Biosensing and Cell Control

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Biosensing using neural probes and cell migration control using patterned topography will be reviewed. Neural probes are used *in vivo* to study neural activities of the central nervous system and retinal responses. We have developed low impedance neural probes with integrated temperature sensors to monitor neural activities in the brain and retina. By controlling the dimension, distribution, and morphology of the electrode sites on the probes, neural signals with high signal to noise ratio were obtained. Improved neural activity detection was achieved by lowering the electrode impedance using plasma treatment of the electrode surface. Position of the implanted neural probes could be monitored using the integrated temperature sensors. These temperature sensors were useful to detect the temperature rise during neural stimulation at different current levels.

Controlling cell movement and cell screening are crucial for biosystems. Cell switches based on patterned topography with different bending angles, segment lengths, and pattern densities have been designed to control unidirectional cell migration with better than 85% probability of passing the switches. To improve the unidirectional passing probability, sealed channels with guidance topography, a height of 15 μm, and a width of 10 μm were used to confine the cells and move them through the channels in the designated direction without external force, chemical gradient, or fluidic flow. This will be the basis for "smart" platform, which is capable of sorting adherent cells to the predesigned locations.

Natural killer (NK) cells serve an important role in immune system by recognizing and killing potentially malign cells without antigen sensitization, and could be important in cancer therapy. We have designed and fabricated microwell arrays with microchannel connections to study the interaction dynamics of NK-92MI cells with MCF7 breast cancer cells using time-lapse imaging. NK cell cytotoxicity was found to be stronger in larger microwells with shorter triggering time of first target lysis. Microchannel connection between adjacent microwell of the same size increased the overall target death ratio by >10%, while connection between microwells of different sizes led to significantly increased target death ratio and delayed first target lysis in smaller microwells. Our findings reveal unique cell interaction dynamics such as initiation and stimulation of NK cell cytotoxicity in a confined microenvironment.